**WE CLAIM:**

1. In a hydraulic machine having a plurality of pistons reciprocally mounted in respective cylinders formed in a cylinder block and positioned circumferentially at a first radial distance about the rotational axis of a drive element, each said piston having a body portion and a head end and each respective cylinder having a valve end and an open head portion beyond which said head end of each said piston extends at all times, and said pistons also having a stroke varying up to a predetermined maximum, the improvement comprising:

- a respective lubricating channel formed in the cylindrical wall of each said cylinder in said cylinder block;
- all of said lubricating channels being interconnected to form a continuous lubricating passageway in said cylinder block; and
- each said respective lubricating channel being substantially closed by the axial cylindrical body of each respective piston during the entire stroke of each said piston, thereby substantially closing said continuous lubricating passageway at all times so that the only source of lubricating fluid supplying said continuous lubricating passageway is a minimal flow of fluid between each said respective cylindrical wall of each said cylinder and said axial cylindrical body of each respective piston.

2. The hydraulic machine of claim 1 wherein said closed continuous lubricating passageway is formed entirely within said cylinder block, transecting each said cylinder and being centered circumferentially at substantially the same radial distance as said cylinders are centered about the rotational axis of the drive element.

3. The hydraulic machine of claim 1 further comprising a sealing member located in proximity to said open head portion of each said cylinder for substantially eliminating blow-by between each said piston and said open head portion of each respective cylinder.

4. The hydraulic machine of claim 1 further comprising a clearance between said respective body portions of said pistons and said respective cylinders selected so that the primary movement of lubricating fluid in said closed continuous lubricating passageway is the result of at least one of (a) piston motion, and (b) changing fluid pressures at said valve end of each respective cylinder that cause said minimal flow of fluid between each said respective cylindrical wall of each said cylinder and said axial cylindrical body of each respective piston.

5. The hydraulic machine of claim 1 in combination with a closed loop of circulating hydraulic fluid and wherein said minimal flow of fluid between each said piston and said valve end of each respective

cylinder is immediately returned to said closed loop without requiring the use of a charge pump.

6. The hydraulic machine of claim 1 further comprising a swash-plate with a flat face, said swash-plate having an inclination relative to said rotational axis of the drive element, and wherein said head end of each piston is maintained in effective sliding contact with said flat face of said swash-plate during all relative rotary motions between said pistons and said swash-plate, said stroke of said pistons being determined in accordance with the inclination of said swash-plate, and said body portion of each piston has an elongated axial cylindrical length sufficient to be supported within said respective cylinder to assure minimal lateral displacement of said head end of said piston when in relative sliding contact with said flat face at all times during said stroke.

7. The hydraulic machine of claim 6 wherein said cylinder block is fixed in a housing, said swash-plate rotates with said drive element and includes a rotor that rotates and nutates, and said flat face is located on said rotor.

8. The hydraulic machine of claim 6 wherein said cylinder block is fixed in a housing and said swash-plate has a split design comprising a rotor that rotates and nutates and a wobbler that only nutates, and said flat face is located on said wobbler.

9. The hydraulic machine of claim 8 wherein the inclination of said swash-plate is variable and the stroke of said pistons varies up to said predetermined maximum in accordance with said inclination.

10. The hydraulic machine of claim 6 wherein each piston has a spherical head end connected to said body portion by a narrowed neck portion, and said machine further comprises:

- a respective sliding shoe pivotally affixed to said spherical head end of each said respective piston and maintained in effective sliding contact with said flat face of said swash-plate during all relative rotary motions between said pistons and said flat face; and
- a hold-down assembly for biasing said sliding shoes toward said flat face of said swash-plate.

11. The hydraulic machine of claim 10 wherein said hold-down assembly comprises:

- a hold-down element having a plurality of respective openings, the boundary of each said respective opening in said hold-down plate being located in proximity to said narrowed neck portion of each respective piston; and
- a respective washer fitted about said narrowed neck portion of each piston between said hold-down plate and each respective sliding shoe, each said respective washer

having an extension aligned cylindrically for circumferentially contacting each said respective sliding shoe;

- said washers being in sliding contact with said hold-down plate for movement relative thereto in response to the changing relative positions of said sliding shoes when said flat face of said rotor is inclined relative to said rotational axis of the drive element.

12. The hydraulic machine of claim 11 wherein the boundary of each said respective opening in said hold-down plate is designed to be in contact with more than one-half of the outer circumference of each said respective washer at all times during said relative movements.

13. The hydraulic machine of claim 11 wherein said machine further comprises a minimal spring bias sufficient to maintain said effective sliding contact between each said respective shoe and said flat face of said swash-plate in the absence of hydraulic pressure at said valve end of each respective cylinder.

14. The hydraulic machine of claim 13 wherein said minimal spring bias is provided by a coil spring positioned circumferentially about the rotational axis of said drive element at less than said first radial distance for biasing said hold-down plate against said washers.

15. The hydraulic machine of claim 13 wherein said minimal spring bias is provided by a plurality of springs, each said spring being positioned respectively between said hold-down plate and one of said respective washers.

16. The hydraulic machine of claim 10 wherein said hold-down assembly comprises only:

- a minimal spring bias sufficient to maintain said effective sliding contact between each said shoe and said flat face of said swash-plate in the absence of hydraulic pressure at said valve end of each respective cylinder, and said minimal spring bias is provided by a plurality of springs, each said spring being positioned respectively between said body portion of each respective piston and said valve end of each respective cylinder.